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(54) Title: A METHOD FOR MANUFACTURING AN ULTRA-HIGH-TENSILE, STRETCH FORMED OR STRETCH BENT SHEET METAL PRODUCT OF STEEL

(57) Abstract: A method for manufacturing an ultra-high-tensile sheet method product of steel, at which the initial work piece used is constituted of a metal work piece of iron, alloyed with chromium, nickel and carbon in predetermined proportions. The initial work piece is wholly or partially plastically cold worked by stretch forming or stretch bending at a predetermined temperature and/or deformation degree, that determines and is determining for the yield point of the final product, in providing a strong deformation hardening, that gives the final product a totally or partially many times increased strength or higher yield point, as compared to the yield point of the initial work piece.

A METHOD FOR MANUFACTURING AN ULTRA-HIGH-TENSILE, STRETCH FORMED OR STRETCH BENT SHEET METAL PRODUCT OF STEEL

The present invention relates to a method for manufacturing an ultra-high-tensile stretch formed or stretch bent sheet product of steel.

When manufacturing stretch formed or stretch bent sheet products one usually starts from metallic work pieces, preferably of a soft steel with good forming properties. During the forming operation one achieves a certain degree of deformation hardening, which however is insufficient for obtaining an ultra-high-tensile final product. In the case one should start from a material that usually is ultra-high-tensile with a yield point preferably more than 700 MPa, this material would not have sufficient ductility to be formed to any greater extent during the stretch forming or stretch bending operation. This is so because the material would brake during the forming operation.

The object of the present invention is to provide a method for manufacturing an ultra-high-tensile stretch formed or stretch bent product of steel, that has initially been alloyed with chromium, nickel and carbon in predetermined proportions. The characterizing features of the invention are set forth in the subsequent claims.

Thanks to the invention one has now provided a method for manufacturing an ultra-high-tensile stretch formed or stretch bent sheet product of steel, which in an excellent matter fulfills its object at the same time as the manufacturing and take place rather rationally when using already existing machines and in modifying the design of certain parts of the tool and/or built in a temperature regulator in the whole or parts of the tool. During stretch forming or stretch bending is now achieved according to invention a final product, in which parts or the whole product has an yield point more than 700 MPa and also values far away over that, for example 1500 MPa. This result with a strong and controlled deformation

hardening of the whole or parts of the product is achieved during the stretch forming or stretch bending operation by that the product is plastically cold worked at least in one step in one or more directions in combination with that the alloy maintains a good ductility during the stretch forming operation with a temperature adapted to the yield point of the final product wanted and at the same time to a deformation degree adapted to the yield point of the final product also wanted. If one has a low or not so high deformation degree and would like a high tensile this can be compensated using a lower temperature, i.e. by cooling the metal work piece before, during or after the working operation by cooling the whole or parts of the stretch forming or stretch bending tool, or by a combination of these criteria during the working operation. If one has a high deformation degree, a deformation hardening can be abstracted in that the work piece and/or the tool is allowed to keep a higher temperature.

The invention is described in more detail below with aid of an embodiment example.

In a preferred embodiment example of the invention the stretch formed or stretch bent sheet product manufactured according to the invention is constituted of a work piece of iron, which as been alloyed with chromium, nickel and carbon in predetermined proportions. In the example chosen the iron has been alloyed with 17% Cr, 7% Ni and 0,1% C or alloys closely related to these and the temperature of the work piece before and/or during the manufacturing operation has been kept or is kept at a controlled level, whereby a strong but controlled deformation hardening is achieved during the stretch forming or stretch bending operation when a plastic cold working of the work piece takes place in combination with maintaining a good ductility of the alloy. Furthermore the temperature of the finally formed stretch formed or stretch bent sheet product can be controlled directly after the working operation itself. The alloyed metal work piece,

that forms the initially work piece according to the invention, can be formed or plastically cold worked in traditional machines but using modified tools for stretch forming or stretch bending in order to increase its yield point from an original, low yield point about 300 MPa to a final product that completely or partially obtains a yield point on more than 700 MPa.

The method functions also in the case you start from for example a medium high yield point i.e. 700 MPa up to a higher i.e. 1000 MPa or higher.

A stronger deformation hardening is obtained during all examples described above if the operation of forming or bending is made in two or several steps.

Claims

1. A method for manufacturing an ultra-high-tensile sheet method product of steel, at which the initial work piece used is constituted of a metal work piece of iron, alloyed with chromium, nickel and carbon in predetermined proportions, **characterized in** that the initial work piece is wholly or partially plastically cold worked by stretch forming or stretch bending at a predetermined temperature and/or deformation degree, that determinds and is determining for the yield point of the final product, in providing a strong deformation hardening, that gives the final product a totally or partially many times increased strength or higher yield point, as compared to the yield of the initial work piece.

2. A method according to claim 1, **characterized in** that the work piece consisting of iron that is plastically cold worked has been alloyed with 17% C, 7% Ni and 0,1% C.

3. A method according to claim 1, **characterized in** that the alloyed work piece is formed in traditional machines for stretch forming or stretch bending but by aid of a modified tool to have an adapted deformation of said metal work piece in order to increase its yield point from an originally low yield point to a final product, that completely or partially obtains a high yield point.

4. A method according to claim 1, **characterized in** that the alloyed work piece is formed in traditional machines for stretch forming or stretch bending that by aid of a modified, partly temperature regulated tool to have an adapted temperature in relation to the deformation which takes place during the stretch forming or stretch bending operation in order to increase its yield point from an originally low yield point to a final product, that completely or partially obtains a high yield point.

5. A method according to any of the preceding claims, **characterized in** that the stretch forming or stretch bending

is made in two or several steps, whereby a stronger deformation hardening is achieved.

6. A method according to claim 1, 2 or 3, **characterized in** that the original low yield point is about 300 MPa and a higher one is more than 700 MPa or from a medium high level of about 700 MPa to a higher level of about 1000 MPa or higher.

7. A method according to claim 1, 2 or 3, **characterized in** that the initial work piece is completely or partially cooled or is kept at a controlled temperature before and during forming operation to obtain a controlled, high strength independently of the degree of the deformation during the forming operation.

8. A method according to any of the preceding claims, **characterized in** that the temperature, to which the work piece completely or partially has been cold to or the temperature that totally or partially is maintained during the forming operation is $-196° <= T <= 70°C$, is determining for the strength of the final product.

9. A method according to any of the preceding claims, **characterized in** that the final sheet product is totally or partially cooled or is kept at a controlled temperature in obtaining a controlled strength increasing independently of the degree of the deformation during the forming operation.

10. A method according to claim 8, **characterized in** that the temperature, to which the final product completely or partially is cold to or the temperature that is maintained after the forming operation is $-196° <= T <= 70°C$.

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A. CLASSIFICATION OF SUBJECT MATTER

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B21D, C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA, EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Stål och värmebehandling/av Karl-Erik Thelning, Volume, No 2, 1985, Thelning, Karl-Erik, "1.8.4. Deformationshärdning", page 62 - page 63, figure 1.46	1-10
X	US 6162308 A (ILSE HECKELMANN ET AL), 19 December 2000 (19.12.00), column 1, line 8 - line 11; column 4, line 37 - line 48	1,3-10
X	US 3871925 A (JOHN NUNES), 18 March 1975 (18.03.75), column 1, line 24 - line 27, claims 3, 6	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"&" document member of the same patent family

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	METALS HANDBOK, Volume, No 8, 1969, ASM HANDBOOK COMMITEE, "FORMING OF STAINLESS STEEL AND HEAT-RESISTING ALLOYS" page 353 - page 371	1-10

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INTERNATIONAL SEARCH REPORT

Information on patent family members

29/04/03

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